FIVE OUTPUT BATTERY CHARGER TYPE MA978F

The MA978F is similar to the MA978A (as described in this Manual) except for the five battery charging lead terminations. The MA978F is fitted with five special connectors to suit the MA4705A battery, as used with the PRM4700 Transceivers.

The following additional items should be added to the Mechanical Parts List for the MA978F.

Description	Racal Part Number
Plug Body	CD709101
Plug Cover	BD709102
Connector	AD709103
Connector Spring	AD709104
Screw M3 x 10 Stainless Steel	921313
Screw M3 x 4 Socket Head	919844

Battery Charger Type MA.978

ALTERNATIVE TRANSISTOR TYPES

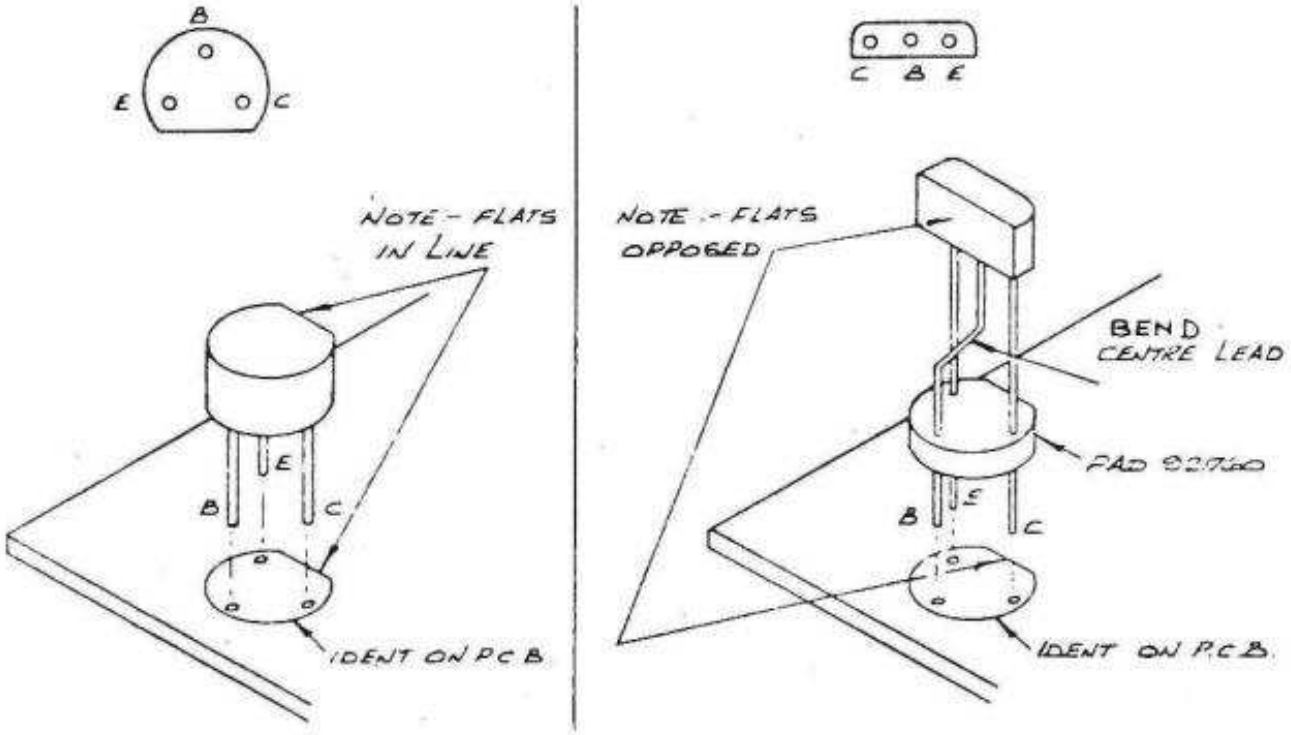
This addendum is applicable to the following equipments:-

CA 531	MA 924L	MA 930P	MA 936	TA 970	MA 985B	MA 990
MA 907	MA 926	MA 930V	MA 937	TA 970H	MA 986B	MA 991
MA 923	MA 927	MA 930X	MA 937B	TRA 971	MA 987	MA 4001
MA 924	MA 930	MA 933	MA 949	MA 978	MA 988	
MA 924B	MA 930L	MA 935	MA 969	MA 984	MA 988B	

'E-line' (ZTX) Transistors may be used as a replacement for the original transistors listed below. Orientation of transistors on printed circuit boards (PCB's) should be carefully noted as illustrated below.

Original Transistor			Replacement Transistor	
Type	Racal Part No.		Type	Racal Part No.
BC 182 SX 3711	917465 915119	} alternative	ZTX 237	923171
BC 212 SX 4060	919122 916092	} alternative	ZTX 212	923172
2N 5450	915133	alternative	ZTX 3705	923170
*2N 5448	915118	alternative	ZTX 3703	923169

Configuration (as viewed from lead side of transistor).



Original Transistor Mounting Method

Replacement Transistor Mounting Method

*TR22 on the MA 924 Series and TR20 on the MA 930 Series are 2N 5448. ZTX 3703 must

FIVE OUTPUT BATTERY CHARGER
TYPE MA.978

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BATTERY CHARGER MA.978	Frontispiece
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FIVE OUTPUT BATTERY CHARGER
TYPE MA.978

INTRODUCTION

1. The Battery Charger MA.978 can be used to charge up to five MA.968A batteries as used with the TRA.965 and TRA.967 transceivers, or up to four MA.980 batteries as used with the TRA.971 Telecal. Each battery may be charged when attached to its associated transceiver by the use of an adaptor lead.

2. Two input supply leads are supplied with the unit; one for connection to an a.c. supply, and one fitted with crocodile clips for connection to a d.c. supply. Either of these leads will connect to the supply plug on the front panel.

CONSTRUCTION

3. The unit is housed in a plastic case of dimensions 290mm (11.4in) x 90mm (3.5in) x 162mm (6.4in). The weight of the unit is approximately 3.05kg (6.7lb).

4. The front panel carries all controls and connectors. These are listed below.

   (a) Supply input plug.

   (b) Supply ON/OFF switch.

   (c) Supply selector switch (120V or 240V a.c., 12V or 24V d.c.).

   (d) Charging indicator lamps (one for each output).

   (e) Battery charging leads (one for each output).

5. Two fuses, one for a.c. and one for d.c. input supplies, are mounted internally.

6. The battery charging leads, which are permanently attached to the battery charger, are terminated in miniature sockets for connection directly into the recessed pins of the batteries. If the batteries are to be charged while they are attached to their associated transceivers, the miniature sockets are inserted into an adaptor cable, which in turn is plugged into an AUDIO socket on the transceiver.

ELECTRICAL CHARACTERISTICS

7.	Input Voltages:	12-15 or 24-30 volts d.c. 100-125 or 200-250 volts a.c., 45-60Hz.
8.	Input Power:	Approximate maximum consumption is 40W.
9.	Output current:	Each output delivers 200mA nominal charging current into a 12V battery.

OPERATING INSTRUCTIONS

10. The battery charger operating procedure is as follows:

NOTE: To prevent damage it is essential that the supply selector switch is correctly set before connecting the supply lead.

(1) Set the supply selector switch to the required position.

(2) Connect the charger to the batteries. The charger leads are terminated in miniature sockets which have to be pressed on to the recessed pins on the batteries (red to red, black to black). If the batteries are to be charged while attached to their associated transceivers, the adaptor lead type CA 701643 should be used. In this case, press the miniature sockets on to the recessed pins on the adaptor, and connect the adaptor lead to an AUDIO socket on the transceiver.

WARNING: DO NOT ATTEMPT TO OPERATE THE TRANSCEIVER DIRECTLY FROM THE BATTERY CHARGER WITHOUT THE BATTERY BEING CONNECTED.

(3) Select the correct input supply lead and connect it to the supply plug on the battery charger front panel. Connect the other end of the input supply lead to the supply as follows:

WARNING: WHEN AN A.C. MAINS INPUT SUPPLY IS BEING USED, ENSURE THAT THE SUPPLY IS SWITCHED OFF BEFORE ANY CONNECTIONS ARE MADE.

A.C. Input Supply Cable		A.C. Mains Supply
Brown Wire	to	Line (L)
Blue Wire	to	Neutral (N)
Green/Yellow Wire	to	Earth (E)

D.C. Input Supply Cable		D.C. Supply
Brown Wire (Red Marker)	to	Positive Terminal
Blue Wire (Black Marker)	to	Negative Terminal

NOTE: Either polarity of the d.c. supply can be earthed.

(4) Apply input power, and set the battery charger switch to ON.

(5) Check the charging indicator lamp for each charging circuit being used. When a battery is being charged, the associated lamp will light. If a lamp is not lit, check that the charging circuit is completed before suspecting a fault in the charger.

NOTE: A fully discharged battery will take approximately 14 hours to charge.

CIRCUIT DESCRIPTION (Figure 3)

A.C. Input Circuit

11. The a.c. supply is connected to pins C and F of free socket SKT1, which mates with plug PL1 on the battery charger. Pins D and E are linked within SKT1. The line side of the supply (pin F) is routed via the supply ON/OFF switch SA2, the link between pins D and E, and FS1, to the 120V primary winding of T2. The neutral side of the supply (pin C), is routed via the supply ON/OFF switch SA1 and the selected contacts on wafer SB1F of the supply selector switch, to the appropriate winding of T2. When 240V input is selected, the two primary windings are connected in series by switch SB1B; the switch connects the windings in parallel when 120V input is selected.

D.C. Input Circuit

12. The d.c. supply is connected to pins C and F of free socket SKT2, which mates with plug PL1 on the battery charger. Pins A and B are linked within SKT2. The positive side of the supply (pin C) is routed via the supply ON/OFF switch SA1 and the selected contacts on wafer SB1F of the supply selector switch, to the centre tap of the 12 and 24 volt primary windings of T2. The negative side of the supply (pin F) is routed via the supply ON/OFF switch SA2, the link between pins A and B, FS2 and D1, to the emitters of TR1 and TR2. D1 protects the inverter against polarity reversal of the d.c. input supply.

13. TR1 and TR2 are connected in a d.c. to a.c. inverter circuit operating as follows. When the supply is made to the circuit, differences in gain and leakage currents cause an unbalance between TR1 and TR2. Assume TR1 passes more current than TR2, an unbalance current will flow in the primary of T2 causing a voltage to be developed. This voltage is applied to the primary of T1. The secondary of T1 feeds the bases of the transistors such that TR1 will receive more base current and hence draw more collector current. TR2 will receive less base current and will tend to turn off. TR1 then becomes fully turned on with nearly the full d.c. supply voltage being applied across half of T2 primary winding.

14. The magnetic flux in the core of T1 increases until it becomes saturated. Immediately this occurs, the secondary voltage collapses, removing the base current from TR1, switching it off. A reverse e.m.f. is produced, applying drive to the base of TR2 which conducts until core saturation occurs in the reverse direction. The process then repeats with TR2 being turned off and TR1 turning on again.

15. This sequence is repeated at approximately 400Hz, the waveform in T2 being a square wave. The output from the secondary is applied to the rectifier circuit.

16. The low voltage primary of T2 is tapped to allow for either 12V or 24V d.c. input; the tappings are selected by the supply selector switch SB2F and SB2B.

Rectifier and Regulator Circuits

17. The output from the bi-phase secondary of T2 is rectified by D1 and D2. C4 is the reservoir capacitor.

18. There are five identical regulator circuits, one for each output. The action of the regulator circuit for output 1 is described.

19. Transistors 1TR1 and 1TR2 form a current regulator. Zener diode 1D3 sets the reference for the base of 1TR1. This sets the potential difference across 1R2 to be the zener voltage less the base to emitter voltage of 1TR1. The current through 1R2 and 1LP1 is thus set, and it is this current which is used to charge the battery.

20. The indicator lamp 1LP1 lights when a charging current is being drawn. 1D4 prevents the battery from being discharged through the battery charger should this fail or be switched off with the battery still connected. 1D5 acts as a reversed polarity protection diode. If a battery is connected incorrectly, the diode is forward biased and a high current is drawn which causes the fuse in the battery to blow.

MAINTENANCE

Equipment Required

21. For the fault-finding and performance checks, the following items of equipment are required:

(a) Multimeter e.g. Avo Model 8.

(b) Resistor 68 ohms 5% 3 watts minimum.

(c) Power supply 0-30V DC at 5A e.g. APT type TCU55.

(d) Variable Transformer, output 0-250V at 2A e.g. Duratrak type V5HM.

Dismantling Procedure

22. The battery charger cover is held in position by two large slotted screws on the back panel. The complete unit is assembled on the rear of the front panel, therefore the cover can be slid off completely once the screws are released. Care must be taken not to lose the rubber sealing ring fitted into the groove around the rear of the front panel.

23. The chassis is held onto the front panel with four screws. Figure 1 shows the underneath view of the battery charger with the front panel tilted away from the chassis. The circuit board, which is held in position on two pillars, is shown pulled back to reveal the chassis mounted components.

Re-assembly

24. This is a reversal of the dismantling procedure. Care must be taken to ensure that the rubber sealing ring is fitted into the groove around the rear of the front panel. The cover is pressed into this groove and the screws at the rear are fastened.

Fault-Finding

25. When charging is taking place, the indicator lamp for each output being used should be lit. Should a lamp not light and the charging circuit is complete, connect the 68 ohms (3 watt) resistor in series with the multimeter (1A range) across the relevant output and measure the current. If the current is between 120mA and 170mA, suspect that the bulb in the relevant lamp has failed. If the output current is less than 120mA, determine whether only one or all outputs have failed.

26. If only one output has failed remove the input power and disconnect all batteries. Open the battery charger and inspect for possible open circuits between the output on the circuit board and the end of the charging lead. If continuity is correct suspect a fault in the regulator components for that particulary output. Table 1 provides a list of transistor voltages that may be used as an aid to fault diagnosis.

27. If all outputs have failed check that the right input selection has been made on the front panel switch, that the unit has been switched on, and that the input supply is correct. Should these checks prove to be correct remove the input power and disconnect all batteries. Open the battery charger.

WARNING: IF MAINS IS BEING USED TO POWER THE BATTERY CHARGER, CARE MUST BE TAKEN TO ENSURE THAT THE TRANSFORMER (T2) TERMINALS AND THE ROTARY SWITCH WAFERS ARE NOT TOUCHED.

28. Check the fuse for the supply being used (FS1 for a.c. supply, FS2 for d.c. supply). If a fuse has failed, investigate and rectify the cause of failure e.g. short circuit, and renew fuse. If the fuses are serviceable, re-connect the input supply and switch on. If a.c. is being used, check that the voltage across C4 (can be measured across pins 2 and 4 of the circuit board) is between 29 and 31V under no load conditions. If this voltage is zero suspect that either T2 is faulty or the wiring between T2 and the circuit board is open circuit. If the voltage across C4 is low, suspect that either 1D1 or 1D2 is faulty, or the wrong voltage tap on T2 has been selected.

29. If d.c. is being used a 400Hz tone from the inverter should be heard. If this tone is present check that the voltage across C4 (can be measured across pins 2 and 4 of the circuit board) is between 22 and 24V under no load conditions. If this voltage is zero suspect that either T2 is faulty or the wiring between T1 and the circuit board is open circuit. If the voltage across C4 is low, suspect that either 1D1 or 1D2 is faulty, or the wrong voltage tap on T2 has been selected.

30. If the tone from the inverter cannot be heard, confirm that the inverter is not working by measuring the a.c. voltage across the low voltage primary windings of T2. If no voltage is present measure the d.c. voltage on the anode (case) of D1. If no voltage is present, suspect that either D1 is at fault, or the wiring between PL1 and D1 is open circuit. If the voltage on the anode of D1 is present, suspect a fault in the inverter. Table 1 provides a list of transistor voltages that may be used as an aid to fault diagnosis.

Performance Check

31. The following procedure enables a check to be made of the charging current for a.c. input.

(a) Set the SUPPLY VOLTAGE switch to 240VAC.

(b) Mate the a.c. supply lead (CA700654/B) to the SUPPLY plug, and connect the wire ended terminations to the variable transformer which should be set to 200V.

(c) Switch the battery charger on.

(d) Connect the 68 ohm 3 watt resistor in series with the multimeter (1A range) across each of the 5 charging outputs in turn. The current output should be between 170mA and 230mA. Note that the lamp should light.

(e) Adjust the variable transformer to 100V, and set the SUPPLY VOLTAGE switch to 120VAC. Repeat check (d).

(f) Switch the battery charger off, and remove connections.

32. The following procedure enables a check to be made of the charging current for d.c. input.

(a) Set the SUPPLY VOLTAGE switch to 12VDC.

(b) Mate the d.c. supply lead (CA 700654/C) to the SUPPLY plug, and connect the crocodile clips to the 5A power supply which should be set to 15V.

(c) Switch the battery charger on.

(d) Connect the 68 ohm 3 watt resistor in series with the multimeter (1A range) across each of the 5 charging outputs in turn. The current output should be between 170mA and 230mA. Note that the lamp should light.

(e) Switch off and set the SUPPLY VOLTAGE switch to 24VDC.

(f) Increase the output of the power supply to 30V.

(g) Switch on and repeat check (d).

(h) Switch off the battery charger and remove connections.

TABLE 1

Typical Transistor Voltages

These voltages were measured on an operational Battery Charger (MA.978).

Transistor	E	B	C	Remarks	
1TR1	21.5	21	1.35	Output 1 Short Circuited	120 or 240V a.c. Input
1TR2	0.8	1.35	26		
1TR3	21.5	21	1.35	Output 2 Short Circuited	
1TR4	0.8	1.35	26		
1TR5	21.5	21	1.35	Output 3 Short Circuited	
1TR6	0.8	1.35	26		
1TR7	21.5	21	1.35	Output 4 Short Circuited	
1TR8	0.8	1.35	26		
1TR9	21.5	21	1.35	Output 5 Short Circuited	
1TR10	0.8	1.35	26		
TR1	0.8	0.08	11.8	+12V d.c. Input	One Output Short Circuited
TR2	0.8	0.08	11.8		
TR1	0.8	0	23.7	+24V d.c. Input	
TR2	0.8	0	23.7		

COMPONENTS LIST

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Chassis Components					
		Resistors	W		
R1	1K	Wirewound	6	5	913662
R2	100	Wirewound	6	5	913686
		Capacitors	V		
C1	0.1	Polyester	160	10	906737
C2	47	Tantalum	35		917478
C3	0.1	Polyester	160	10	906737
C4	1000	Electrolytic	40	+50 -10	919117
C5	0.1	Polyester	100	20	915502
		Transformers			
T1					CT710016
T2		Mains			CT710161
		Switches			
SA		DPDT Sealed Lever	3A		930821/EQ
SB		Rotary			BR711088
		Transistors			
TR1		2N3055			906371/EQ
TR2		2N3055			906371/EQ
		Diodes			
D1		6FR5			920025/EQ
D2		10D1			909879
		Connectors			
PL1		Plug 6-way			929140
		Fuses			
FS1		500mA			990989/EQ
FS2		4A			906931/EQ

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Chassis Components contd					
		Lamps			
1LP1 to 1LP5		Bulb 4.5V	0.27W		916078
		Lampholder (Yellow)			916077
		Supply Leads			
		A.C. lead			CA700654/B
		D.C. lead			CA700654/C
Circuit Board Components					
		Resistors	W		
1R1	3.3K	Composition	0.1	10	902514
1R2	27	Wirewound	2.5	5	913582
1R3	1K	Composition	0.3	5	924680
1R4	3.3K	Composition	0.1	10	902514
1R5	27	Wirewound	2.5	5	913582
1R6	1K	Composition	0.3	5	924680
1R7	3.3K	Composition	0.1	10	902514
1R8	27	Wirewound	2.5	5	913582
1R9	1K	Composition	0.3	5	924680
1R10	3.3K	Composition	0.1	10	902514
1R11	27	Wirewound	2.5	5	913582
1R12	1K	Composition	0.3	5	924680
1R13	3.3K	Composition	0.1	10	902514
1R14	27	Wirewound	2.5	5	913582
1R15	1K	Composition	0.3	5	924680
		Capacitors	V		
1C1	0.1	Disc Ceramic	250	+40 -20	916187/EQ
1C2	0.1	Disc Ceramic	250	+40 -20	916187/EQ
		Transistors			
1TR1		ZTX 212			923172
1TR2		TIP31			922492
1TR3		ZTX 212			923172
1TR4		TIP31			922492
1TR5		ZTX 212			923172

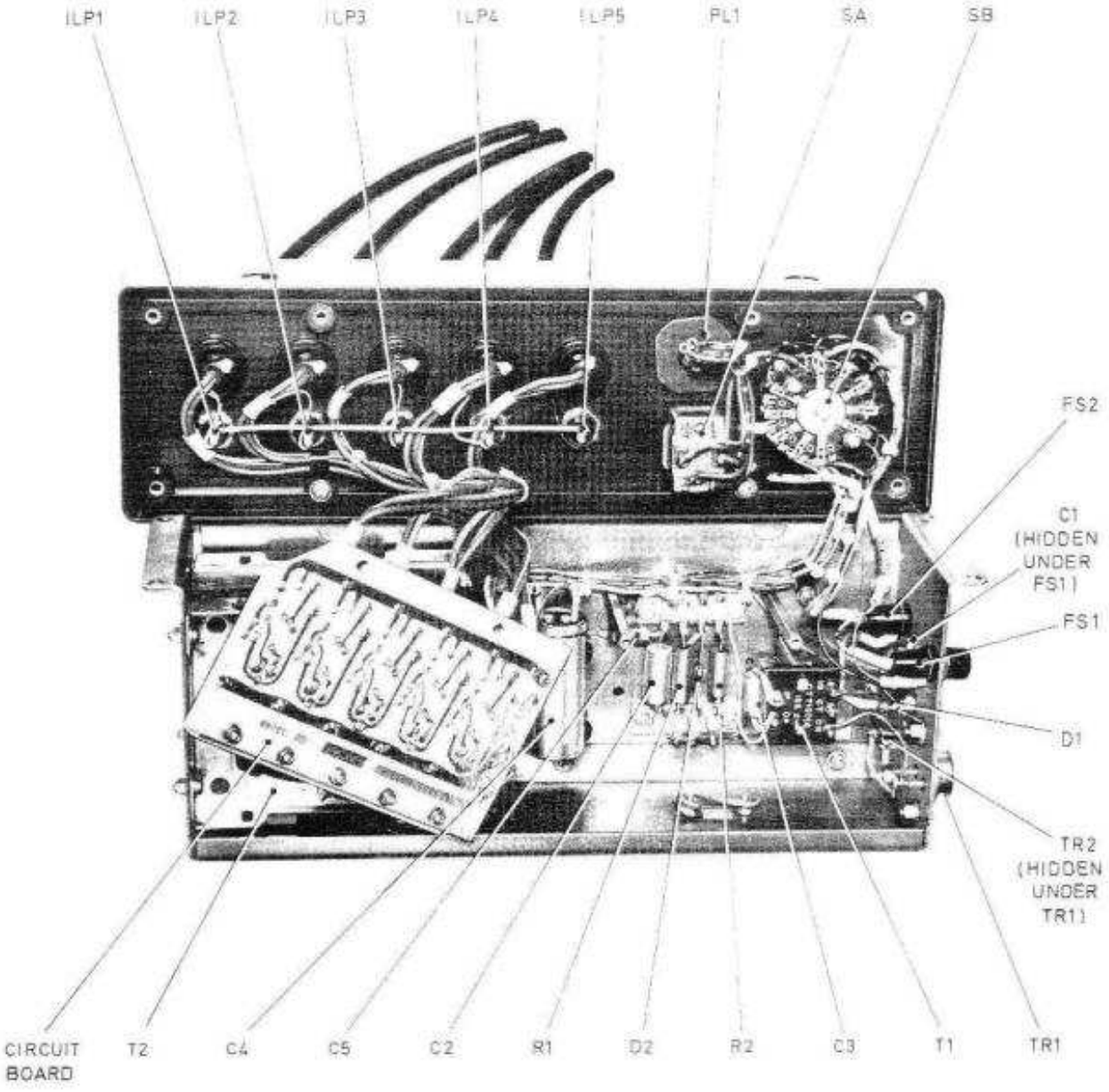
Cct. Ref	Value	Description	Rat	Tol %	Racal Part Number
Circuit Board Components contd					
		Transistors			
1TR6		TIP31			922492
1TR7		ZTX 212			923172
1TR8		TIP31			922492
1TR9		ZTX 212			923172
1TR10		TIP31			922492
		Diodes			
1D1		1R3052			921357
1D2		1R3052			921357
1D3	4.7V	BZY88 C4V7			914067/EQ
1D4		1N4002			911460/EQ
1D5		1N4002			911460/EQ
1D6	4.7V	BZY88C4V7			914067/EQ
1D7		1N4002			911460/EQ
1D8		1N4002			911460/EQ
1D9	4.7V	BZY88C4V7			914067/EQ
1D10		1N4002			
1D11		1N4002			911460/EQ
1D12	4.7V	BZY88 C4V7			914067/EQ
1D13		1N4002			911460/EQ
1D14		1N4002			911460/EQ
1D15	4.7V	BZY88 C4V7			914067/EQ
1D16		1N4002			911460/EQ
1D17		1N4002			911460/EQ

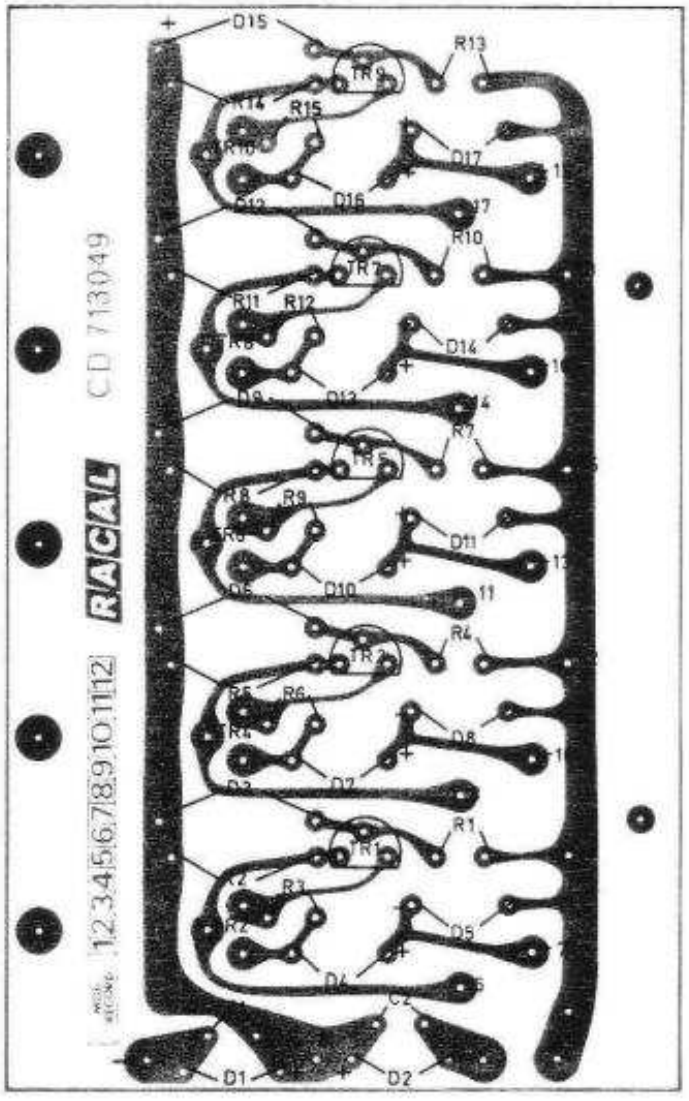
MA 978 FIVE OUTPUT BATTERY CHARGER

MECHANICAL PARTS LIST

Description	Racal Part Number
Boot Resistor	703073
Boss	706126
Bracket	706125
Bush Transistor	921793
Cable Tie	915371/EQ
Cap Electrical	711069
Case Battery Assy	706245
Cover	701586
Fastener Special	701074
Frame	701587
Gland Cable	991097/EQ
Grommet Half	919956
Heatsink	706128
Insulator Mica	935337
Lampholder Yellow	916077
Nut	906368
Nut	912542
Nut Case	702963
Nut M2.5	917826
Nut M3	920597
Nut M3	917825
Nut M4	923858
O Ring	711130
Pad Transistor	921760/EQ
Panel Front	701588
Pillar	701215
Pillar	700123-20
Pin	926428
Plasklip	900096
Plasklip	900205
Plasklip	900123
Plasklip	905625
Ring Retaining	921786
Ring Rotaining	934911
Screw	909904
Screw M2.5X10	917823
Screw M3X10	917818
Screw M3X12	935085
Screw M3X30	933201
Screw M3X6	917844
Screw M3X8	917845
Screen M4X20	922362
Seal O Ring	909887
Seal Rubber	706124
Strap Carrying	711038
Washer	702001
Washer	904240
Washer	904252
Washer	906268
Washer M2.5	916074
Washer M2.5	918653
Washer M3	918086
Washer M3	925588
Washer M3	917705

Description	Racal Part Number
Washer M3	928759
Washer M4	918087
Washer M4	917706
Washer M5	918661
Washer	916074
Washer M2.5	917704


ILP1
ILP2
ILP3
ILP4
ILP5
PL1
SA
SB
FS2
C1 (HIDDEN UNDER FS1)
FS1
D1
TR2 (HIDDEN UNDER TR1)
CIRCUIT BOARD
T2
C4
C5
C2
R1
D2
R2
C3
T1
TR1

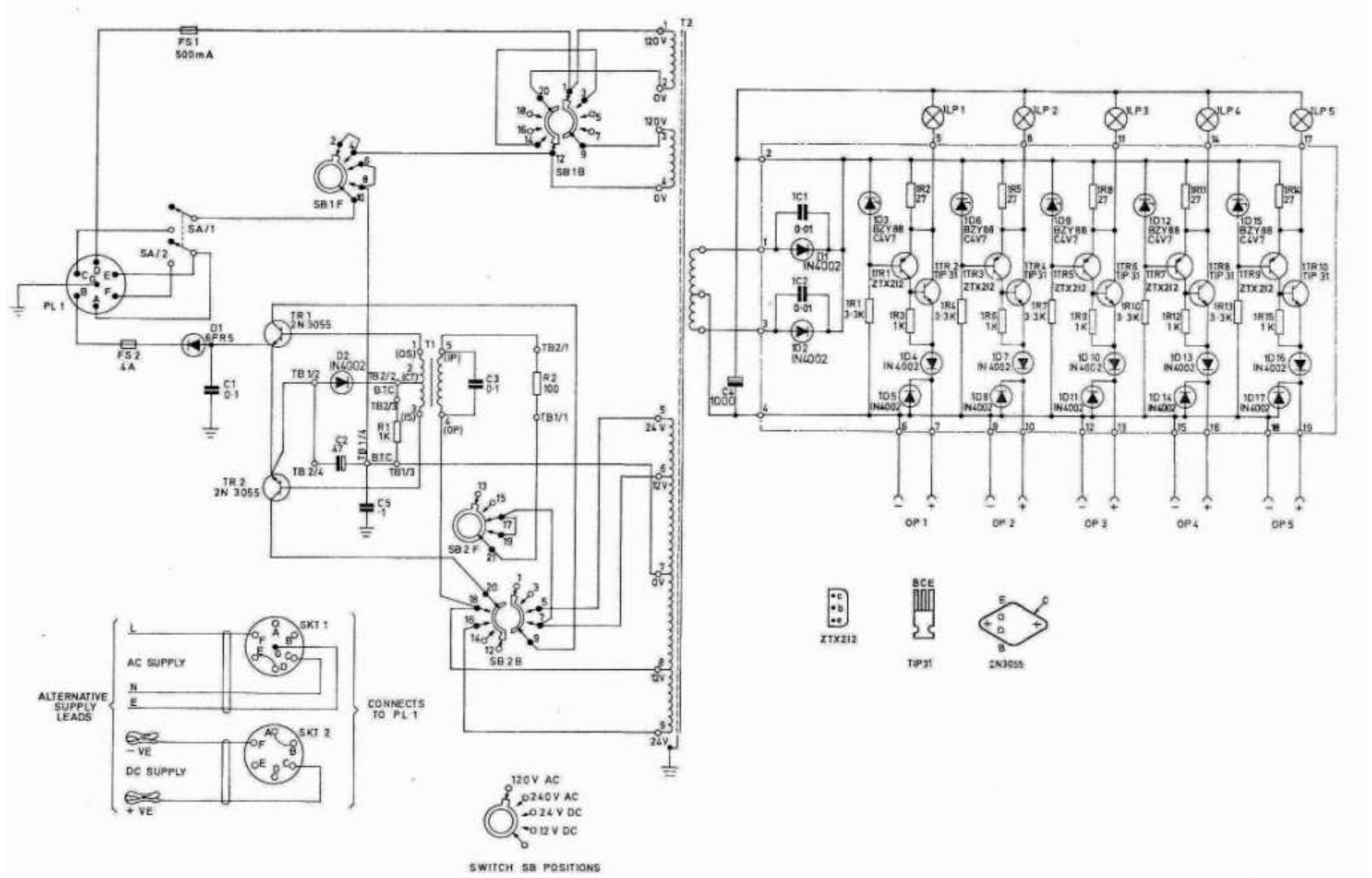


ALL COMPONENTS PREFIXED 1

WOH 3105	CD 713049
1	

WOH 3105 CD713049

Layout: P.C. Board Battery Charger MA.978 Fig. 2



WOH3105	CC701204
1 2 3 4	

Circuit: Battery Charger MA.978

Fig. 3